Defining that

A: the number of long codes to be searched,

Q: the number of phases of the entire chips of a long code to be searched,

PG: the processing gain,

M: the number of symbols to be integrated for correlation detection,

Tc: chip period,

NSC: the number of sliding correlators,

NMF: the number of matched filters

TSC: acquisition time of the sliding correlators, and

TMF: acquisition time of the matched filters, the acquisition times of the sliding correlator and the matched filter become as follows when there are no thermal noise, or no cross-correlation due to interference from the delayed waves from other users or its own channel signal.

In the case of the sliding correlator:

$$T_{SC}=A\times Q\times PG\times M\times T_C/N_{SC}$$

In the case of the matched filter

$$T_{MF}=A\times Q\times M\times T_C/N_{MF}$$

When using the long code, since the number A of long code and the number Q of phases to be searched are enormous, there is a problem in that it takes a very long acquisition time.

DISCLOSURE OF THE INVENTION

As described above, a mobile communication system using long codes has a problem in that it takes a very long time for a mobile station to establish the acquisition of the spreading code before capturing a control channel from a base station after the mobile station is powered up.

Furthermore, to capture a channel in a cellular environment in which time synchronization is not established between base stations, a receiver must carry out code search, an operation for detecting a spreading code used for spreading the signal on a receiving channel. In practice, the receiver must detect spreading codes used for spreading signals transmitted through channels from a plurality of base stations to receive one of the signals. Subsequently, the receiver establishes the acquisition, and measures the received level to determine the channel to be connected. Thus, the time period taken to complete the acquisition of the channel in the cellular environment corresponds to that needed for the code search, and hence it takes an enormous time when the long spreading code is used for spreading.

Moreover, in the mobile communication environment, the cell or the base station with which the receiver (mobile station) communicates changes as the receiver moves. To achieve the switching, the receiver must carry out the cell search by measuring the received levels by regularly establishing the acquisition of the spreading codes on channels connected to base stations surrounding the current base station with which the receiver is communicating at present.

Therefore, it is an object of the present invention to provide a signal transmission method, transmitter and receiver, and a spreading code synchronization method, which can achieve fast, highly accurate acquisition of the spreading codes in a mobile station in a mobile communication system using long codes.

According to the first aspect of the present invention, a signal transmission method in a mobile communication system in a direct sequence CDMA communication system which transmits a wideband signal spread using a spreading code with a rate higher than an information rate, the signal transmission method comprises the steps of:

using a first spreading code group and a second spreading code group, the first spreading code group being common to respective base stations and having a period equal to an information symbol period, and the second spreading code group being different from base station to base station and having a period longer than the information symbol period; and

masking, when transmitting a signal which is doubly spread using a first spreading code in the first spreading code group and a second spreading code in the second spreading code group, the second spreading code for M symbols at fixed intervals, where M is a natural number equal to or greater than one.

Here, the receiver in a mobile communication system may comprise:

first synchronization detecting means for detecting a synchronized time of a first spreading code from a detection time of a correlation output value, the correlation output value being obtained through a correlation detection processing between a spread modulation signal obtained by receiving a signal transmitted by the transmission means of claim **1** and a first spreading code in the first spreading code group of claim **1**; and

second synchronization detection means for performing correlation detection sequentially using codes obtained by multiplying the first spreading code by A (A is a natural number) second spreading codes in the second spreading code group of claim **1**, and for deciding a second spreading code having a maximum correlation value, wherein the correlation detection is started from a time position at which a maximum correlation value is detected by the first synchronization detection means.

Here, the receiver of a mobile communication system may comprise:

first spreading code synchronized phase memory means for storing B dominant time positions in descending order of magnitude of correlation values detected by the first synchronization means of claim

second spreading code synchronization detecting means for performing correlation operations sequentially between a received signal and codes obtained by multiplying the first spreading code of claim **1** by B spreading codes in the second spreading codes of claim **1** of contiguous base stations of a current base station of which the current base station notifies, wherein the correlation operations are started from time positions stored in the first spreading code synchronization memory means, and are carried out in descending order of magnitude of the correlation values stored in the first spreading code synchronization memory means; and

means for detecting which codes of the second spreading codes correspond to the B dominant time positions of the first spreading codes of claim **1**.

Here, the spreading code synchronization method may comprise the steps of:

performing correlation detection between a received spread modulation signal and codes obtained by multiplying the first spreading code of claim **1** by second spreading codes of the second spreading code group of claim **1** to decide the second spreading code used for spreading the received spread modulation signal,